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On-line tool for the assessment of sustainable urban transport policies

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Abstract

European cities face increasing challenges to their citizens' mobility. Urban transport systems are integral elements of the European transport system and are therefore of concern for the Common Transport Policy. Thus, the 2011 Transport White Paper calls for cities to implement a range of strategies to face these challenges - strategies include: land-use planning, pricing schemes, efficient public transport services, infrastructure for non-motorised modes and charging/refuelling of clean vehicles to reduce emissions – and encourage to develop Urban Mobility Plans (SUMP) that bring all of these elements together.

Tools and guidance documents are key instruments for the development of these strategies in order to help city authorities understanding the range of possible actions and steps to successful implementation. This paper presents an overview of the web based policy support tool developed in the European Urban Roadmaps study, supported by DG Move and underpinned by a range of stakeholders' engagement activities.

The aim of the web based tool is to support authorities of small and medium sized cities in Europe who may not have the resource to major policy assessment and modelling work. The tool provide the local transport policy maker with the ability to readily identify, develop, screen and assess different measures and policies scenarios, thereby enabling city authorities to quickly gather a sense of the scale of impacts that could be expected. It is adaptable to different city circumstances, covers all the transport/travel modes that are used in urban areas and provides quantitative outputs covering a range of different metrics, including costs and cost effectiveness, covering the time period until 2030.

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The development of the tool is complemented by the preparation of different road maps, designed to provide examples of policy selections that could be implemented by a city to work towards the European Commission goals for sustainable urban transport until the year 2030.

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1. Background

Many cities in Europe face increasing challenges to their mobility systems such as congestion, air quality, ambient noise, CO₂ emissions, accidents and urban sprawl. These have significant negative impacts on the environment and economic performance of cities and problems are expected to increase in the future as cities continue to grow in size and face demographic changes.

Being integral elements of the European transport system, urban transport systems are of concern for the Common Transport Policy. The 2011 Transport White Paper sets ambitious targets for urban mobility. Meeting these targets will not happen autonomously as a result of technological development or market forces and consequently, policy action is needed at the city level in order to ensure that the objectives for urban transport are met.

The availability of tools and guidance documents is central to the development of cost-effective strategies, helping policy-makers to understand the range of possible actions and steps to successful implementation.

Whilst there is already a wide variety of transport tools and models available, many of these are full-featured, commercially available software packages suitable for highly detailed traffic and transport modelling. Such tools are able to model the impacts of transport schemes and policies in detail, but their complexity means that they are not accessible to staff in city authorities with no background or experience in modelling.

For this reason in 2013 DG MOVE launched a “Study on European Urban Transport Roadmaps 2030”, a four-year project with the specific objective of providing effective and user-friendly policy support tools to assist a wide range of city authorities throughout Europe to identify and implement the most cost-effective policies to achieve European urban transport policy goals.

Designed to support the assessment of a wide range of transport policy measures, the tool allows city authorities in developing and analysing policy scenarios and roadmaps and in getting quantified estimates of the impacts and costs of individual policy measures or of their combinations. The tool operates in a web-based software environment to enable ease and use and to avoid the need for specific software packages.

This paper presents the main features of the Urban Transport Roadmaps 2030 policy support tool and is structured as follows: in section 2 the main objectives and functionalities of the tool are introduced; the structure of the tool and of its modules is described in section 3 while section 4 provides an overview of the next steps of the tool development. Final conclusions are presented in section 5.

2. Scope and functionality of the tool

The development of the tool was centred on the following core objectives:

- To provide cities with the ability to readily identify, develop, screen and assess different transport policies and measures;
- To allow cities to explore different urban transport policy scenarios, thereby enabling city authorities to quickly gather a sense of the scale of impacts that could be expected based on illustrative policy scenarios;
- To provide cities with quantitative outputs covering a range of different metrics, including costs and cost effectiveness, covering the time period up to 2030;
- To be adaptable to different city circumstances;
- To be very easy to use, and in particular be accessible and usable by people with no background or experience in transport modelling;

- To have visually attractive interface and outputs and to provide very high quality graphical outputs that can be used by city authorities to communicate with a wide range of stakeholders;
- To be readily accessible and not rely on users having access to specific types of software or be limited to users with computers that run on particular operating systems;
- To cover all of the transport/travel modes that are used in urban areas, i.e. cars, vans, heavy goods vehicles, buses, bicycles, motorised two wheelers and walking.

The tool was developed around four main structural elements as illustrated in Figure 1. These elements, developed into dedicated modules described in the sections below, comprise:

1. City type selection
2. Policy selection
3. Calculation framework
4. Tool outputs

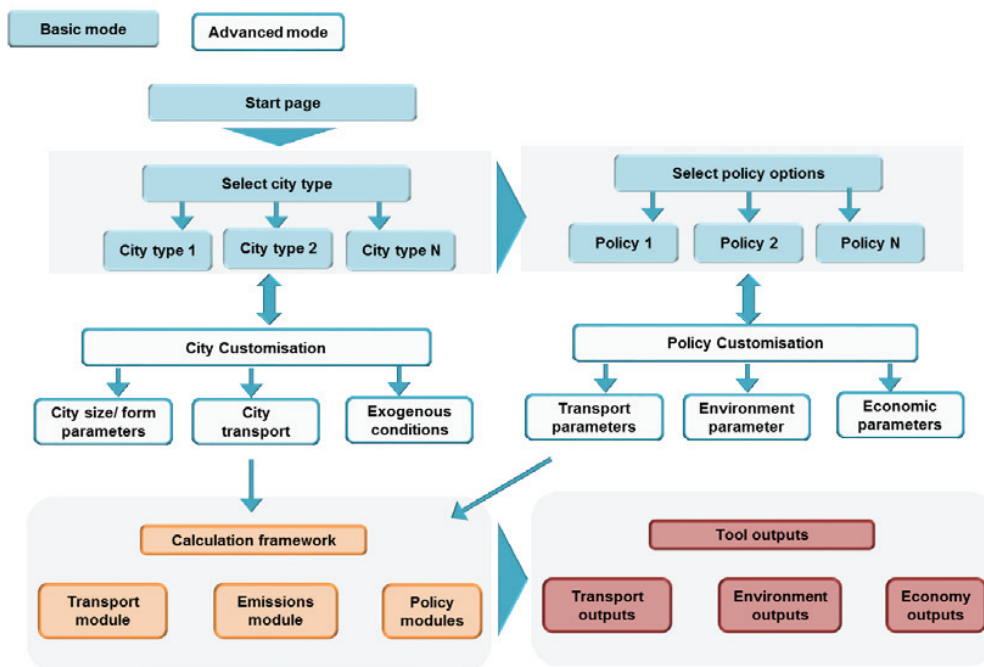


Fig. 1. Outline structure of the tool.

2.1. The city type selection module

The **city type selection** module is the main entry point of the tool and allows the user to select a primary city type to represent their city. Each primary city type is associated with a set of default city and transport parameters that allows the model to set up the most appropriate basic transport patterns. This allows simple and quick initial configuration of the model. The key information needed by the module includes:

- **City type:** Small city (<100,000 inhabitants), Small city with large historical cores, Medium city (100,000 – 500,000 inhabitants), Large city (500,000 to 1 million inhabitants) and very large cities (over 1 million inhabitants, in either monocentric or polycentric forms).

- **Country:** Country average national data is used to automatically set the initial values of parameters such as e.g. car ownership, vehicle fleet composition, car ownership taxes, energy mix for electricity generation, etc.
- **Population:** Population (total and by zone) at the base year and its trend.
- **Economy:** City economy type (e.g. relevance of the industrial sector, which influences freight traffic patterns).
- **City users:** Share of incoming trips with respect to internal trips, main transport mode used to enter the urban area, including multimodal trips (e.g. park & ride is also simulated within the tool).
- **City population distribution:** Share of inhabitants living in three area types: urban core, outskirts with good transit service and outskirts with poor transit service.
- **Relevance of non-car modes of transports:** Use of public transport, existence of tram and metro lines, use of bikes, use of motorbikes.
- **Road congestion level.**

More advanced users find in the tool the possibility to customize the default data using their own local data so as to provide a more accurate representation of the city, both on the demand and on the supply side. If not customised by the user, the default values of the following variables are based on average data derived from the model database:

- Socio-demographic trends: population trend and sprawling trend,
- Average income level per capita,
- Transport trends: mode split trend, share of freight traffic and its trend,
- Availability of electric or fuel cell refuelling stations ,
- Public transport fares and operating costs,
- Extension of reserved paths for bus/tram or bike,
- Extension of regulated parking and parking fares,
- Existence and level of service of park & ride,
- Existence and level of service of car sharing,
- Vehicle fleet composition by fuel type for car and bus ,

The user can also choose among alternative exogenous trends influencing the development of transport activity and its effects:

- technology: penetration of innovative vehicle technology in the fleet, trends of fuel economy and polluting emission factors,
- energy and mobility: fuel resource price, car ownership trend, trip rates trend, energy mix for electricity generation,
- policy at the national or super-national level: fuel taxation, vehicle taxation.

2.2. The policy selection module

Having selected a city type, and potentially customised it, within the **policy selection** module the user can then select various policies to apply in their city.

The definition of policy measures to be included in the tool was a key step of the project. The ELTIS, CIVITAS and EPOMM websites provided a wide range of examples of individual actions to promote sustainable mobility. And their screening allowed for the identification of a set of core policy measures detailed in Table 1. These policy measures can be simulated individually or combined together in consistent scenarios and roadmaps.

Table 1. Urban Transport Roadmaps 2030 Policy Measures.

Policy Type	Measure
Demand management	<ul style="list-style-type: none"> • Sustainable travel information and promotion • Bike Sharing Scheme • Car sharing (Car Clubs) • Delivery and Servicing Plans • Land-use planning - density and transport infrastructure
Green Fleets	<ul style="list-style-type: none"> • Green energy refuelling infrastructures • Green public fleets
Infrastructure Investments	<ul style="list-style-type: none"> • Bus, trolley and tram network and facilities • Walking and cycling networks and facilities • Park and ride • Metro network and facilities • Urban Delivery Centres and city logistics facilities
Pricing and financial incentives	<ul style="list-style-type: none"> • Congestion and pollution charging • Parking regulation and pricing • Public Transport integrated ticketing and tariff schemes
Traffic management and control	<ul style="list-style-type: none"> • Legal and regulatory framework of urban freight transport • Prioritising Public Transport • Access regulation and road and parking space reallocation • Traffic calming measures

2.3. The calculation framework

The calculation framework is the core of the tool that uses city type and policy measure parameters to calculate the impacts of policy measures in the selected city.

In the calculation framework the urban mobility system is described at a strategic level (e.g. networks are not represented) from 2015 until 2030 on a yearly basis. A reference trend of the urban mobility and of its effects (e.g. local pollution) is computed; the impact of policy measures is measured in terms of modifications of such trend.

The calculation framework comprises three key elements (Figure 2):

- **The transport module**, which calculates the base transport patterns for the city and then adjusts them in relation to the policies.
- **The emissions module**, which calculates the emissions and environmental data associated with the transport activity.
- **The policy modules**, which translates the policies into impacts.

2.3.1. The transport module

The **passenger transport demand** sub-module deals with the estimation of trip generation and mode split for passenger mobility. Passenger-km numbers depend on average trip distances, which are different according to the living zones (shorter in the core urban area, longer in the outskirts). Vehicle-km numbers depend on occupancy rates, which can also be affected by policies. Trip generation is based on trip rates by journey purpose and time period of the day applied to urban population by zone, while mode split depends on the initial assumptions set by the user. The distribution of trips among zones is not modelled (since transport network loads are not simulated), only trips with destination in the urban area under analysis are estimated. Policy measures can change mobility trend and give rise to mode switches.

Main elements affecting mode split and transport activity are travel times and costs. Travel time by mode is calculated building on a base speed by mode, which changes over time due to the effects of road traffic levels. Importantly, in addition to congestion, road speed depends also on whether or not there are reserved lanes for public

transport and bicycles¹. A dedicated sub-module (*incoming passenger demand*) estimates passenger trips entering the city from other areas.

Mobility-related costs are computed for both individuals and city administration. The costs considered for individuals are:

- for private cars, fuel costs as well as local charges (parking, road pricing) and fixed costs (insurance, ownership taxes);
- for motorbikes, fuel costs only;
- for other modes the expenditure for purchasing transport services (public transport, bike sharing, car sharing) are considered.

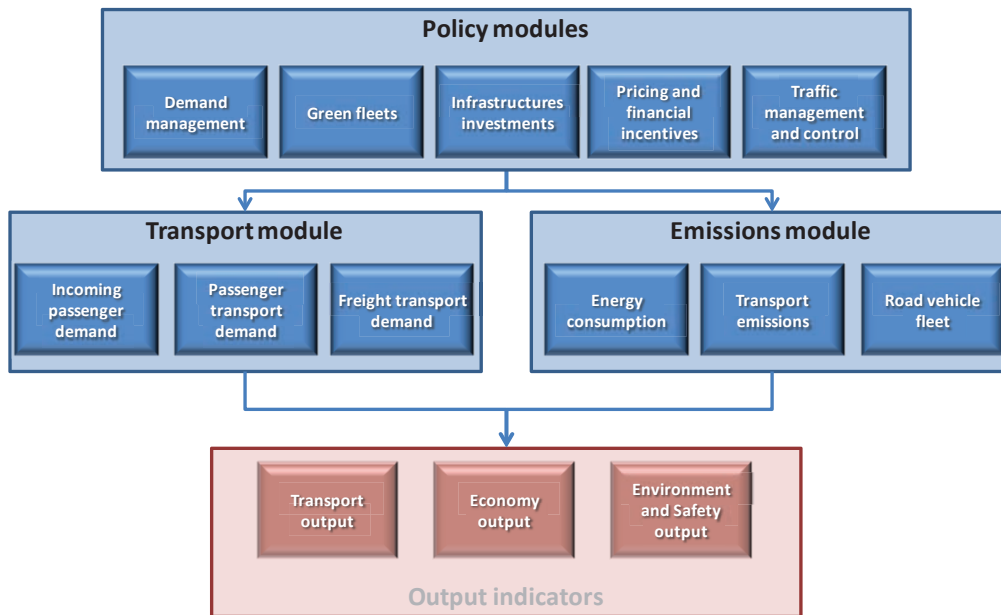


Fig. 2. Outline structure of the calculation framework.

From the public administration point of view, the costs are those for operating public transport services and, when policy measures are activated, for their implementation and operation. Costs are modelled net of the revenues obtained from public transport users, from parking, and from road charging. Revenues for services and taxes not controlled at the local level (e.g. car ownership taxes, fuel taxes) are not accounted for.

The number of freight vehicles is estimated in the freight transport demand sub-module as a percentage of the total number of passenger car vehicles. Within the module there is a differentiation by freight traffic typology and truck size. Three types of freight traffic are considered: distribution of products to retailers, mail services (couriers delivering to and collecting packages from offices and households) and other types of freight transport (e.g. movements of building materials, transport of input for the industrial process or of products of local industries). This distinction is introduced for two reasons. First, several measures are focussed on urban deliveries and therefore affect only one component of freight traffic. Second, the types of vehicles used for mail distribution are different from the vehicles used for transporting input to an industry. The module also calculates the amount of transhipped shipments (those which arrive in a platform within the urban area to be consolidated). This amount could be currently zero in many

¹ Reserved lanes of this nature improve the journey speeds of public transport modes and of bicycles and reduce the speed of cars as they reduce the space on the carriageway.

urban areas but can become different from zero when certain policies are activated. Finally, performances related to vehicle-km are estimated, taking into account the urban part of the overall trip distance.

2.3.2. The emissions module

In the road vehicle fleet sub-module, the fleet composition in terms of fuel type evolves over time driven by the penetration of innovative vehicles such as hybrid electric, battery electric and fuel cells. This trend is defined by the technological scenario selected in the exogenous conditions. The composition by Euro emission standard is also taken into account in order to estimate the average polluting emission and fuel consumption factors of the fleet.

The car sharing vehicle fleet as well as the LDV fleet for distribution of goods from the urban delivery platforms are treated separately under the assumption that their compositions are different from the private car and truck fleet (e.g. the car sharing fleet is usually made up of new vehicles and from urban delivery platforms also electric vehicles can be used).

Road vehicle fleet composition is the main input of the transport emissions module to estimate fuel consumption, pollutant and CO₂ emissions. Total values are computed by applying mode-specific consumption and emission factors to the transport performance in vehicle-kilometres travelled (provided by the passenger transport module, incoming trips module and freight module). Tank-to-wheel CO₂ emissions are estimated directly from fuel consumption by applying the fuel carbon content factors to each fuel type. For electricity consumption (tram, metro, electric cars), the energy mix for power generation is taken into account in order to estimate the emissions despite the fact that such emissions do not usually occur in urban areas. The energy mix changes over time at the country level according to the energy scenario.

2.3.3. The policy modules

Each policy measure is simulated in a dedicated policy module and each policy module is linked to one or more of the core modules described above to read input and to feed back the related impact.

Different measures can have impacts on the same variables (e.g. the transport mode shares) and these measures can be either independent or have a mutual influence. Impacts of independent measures are modelled in additive terms, while for the mutually influencing measures impacts are smoothed or amplified. Each policy module includes specific variables, but all share a similar concept that is based on the following input:

- The time when the measure is activated or enters into force.
- The ramp-up period for the full implementation of the measure. Some measures are relatively easy to implement and it can be safely assumed that their impacts occur in the same year of implementation. Other measures are more complex (e.g. infrastructures) and need several years before being fully implemented and/or to achieve their full effect after an adaptation period.
- The specific policy characteristics and intensity. For instance, for road charging the parameters include the value of the charge, its differentiation between vehicle types, and the size of the charged area.

Based on these input the policy module:

- Identifies the variables affected by the measures. For instance, the introduction of urban delivery centres increases the share of freight deliveries transhipped and consolidated at urban platforms. The prioritisation of public transport improves its speed and therefore its modal share. Here the user has the chance of modulating some of the effects.
- Quantifies the implementation and management costs of the measures. Some policies have almost direct no costs associated with them except administrative costs (e.g. the introduction of a legal and regulatory framework for urban freight transport), but most of them require investment to build infrastructure (e.g. park and ride facilities, reserved lanes, etc.) and a yearly management and management cost (e.g. as is the case for road charging schemes).

As an example, the policy measure *Car sharing (car clubs)* simulates the introduction of a new car sharing service in the urban area. It is modelled under the assumption that the service has a *fixed* element (e.g. annual subscription) and a *variable* element (pay per use costs) to the user charges. It is also assumed that the number of cars (and of collection points) can be variable from case to case (i.e. smaller or larger) and therefore a different time might be

needed to reach a car. The tool provides the choice between two different types of car sharing: *one-way system* (cars collected and returned in any point in the city) or *collect-and-return system* (cars returned to specific parking slots). The tariffs and accessibility of cars in the scheme affect the number of people subscribing the car sharing services. Assuming that on average each subscriber uses the service for a certain number of trips per year, a number of trips is computed. These trips replace trips made by other modes and depending on the type of car sharing different modes are affected. The result will be a modification of mode shares. It is assumed that the service is operated by private companies that pay an annual fee to the municipality in compensation of free parking, free entrance in charged areas (where they exist) and so on.

Another example of policy measure that can be simulated is *Congestion and pollution charging* i.e. the application of a toll for entering a certain portion of the urban area aimed at reducing traffic and/or local pollution. The difference between the two options is that in the former case the toll level does not depend on the environmental impacts of the vehicles whereas in the latter case it does. The policy is implemented as a charge applied to cars and trucks (buses, motorbikes and car sharing cars are considered exempted). The level of the charge (for car and truck separately) can be customised by the user as well as its differentiation between vehicles meeting specific emissions standards (i.e. Euro class) and/or between peak and off-peak time. Also the share of the city area subject to the charge can be defined by the user. On the basis of different cost elasticities, varying by trip purpose, the application of the charge affects car use and induces some mode shift.

On the freight side it is assumed that forwarders react to charges by improving the efficiency of loads and thus reducing the number of freight vehicles. If the charge is differentiated by Euro emissions standard another effect is the acceleration of the fleet renewal (which of course progressively reduces the effectiveness of the measure). The implementation and the management of the system has some costs for the public administration, which, on the other hand, collect the revenues of the charge.

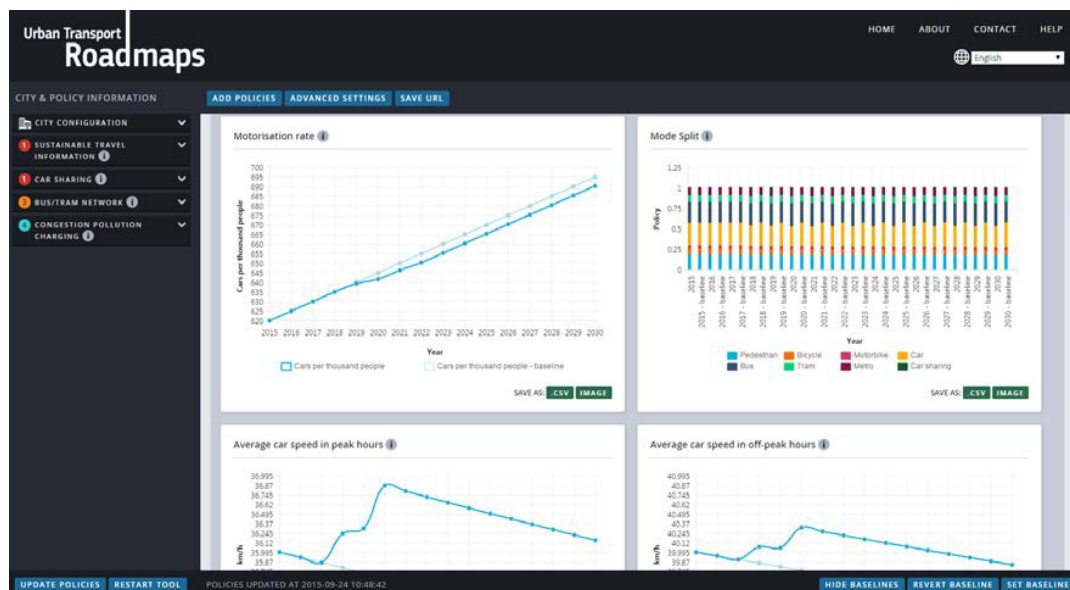


Fig. 3. Tool's interface.

2.4. The outputs module

The **outputs module** provides the numerical and graphical representations of the impacts of the transport policies on the city. The indicators for scenario assessment (in absolute values as well as in terms of absolute and relative difference with respect to the reference scenario) are segmented into three domains:

- *Transport impacts*, including mode share, average trip distances and traffic levels;
- *Environment outputs*, covering CO₂, CO, PM, NO_x and VOC emissions and accident rates;
- *Economic outputs*, providing the direct cost/benefits associated with the policies, and the social cost of emissions and accidents.

2.5. Data sources

It is worth considering that the strategic nature of the tool and the need for a flexible structure that can be customised to meet the needs of a large number of urban areas made challenging the task of populating the calculation framework with data. Many elements required in the calculation framework are context specific. Examples are the average trip distance by mode, the trip distribution between peaks and off peak periods, but there are many others.

Also, the impacts of policy measures are highly context-sensitive as the implementation under real-world conditions is important. Furthermore, the aggregated level of the tool required to quantify the impacts of changes in transport demand at a very general level which is not necessarily what can be found in the research literature. Finally, many initial elements of the model, but also several elasticity parameters that influence policy impacts are not locked and hidden in the model structure but available for users' adaptations. What is needed for these elements is not an exact value, but rather a plausible starting point. All these aspects mean that the data set for the tool is a combination of robust literature-based parameters (e.g. emissions factors), generalisations of data based on case studies and estimates based on professional judgment when needed.

Therefore, the parameters driving the calculation framework (including the impacts of the policies) have been estimated on the basis of a wide range of data sources: travel surveys, Eurostat database, national statistics, modelling source (e.g. ASTRA-EC model, TREMOVE model), policy focused researches, professional literature, project reports, urban traffic studies, conference papers. As an example, about 70 different documents were used as a reference to estimate the parameters driving the impacts of the policies. Furthermore, whenever possible and meaningful, parameters were differentiated by countries (e.g. car ownership, PT production costs by mode, energy mix for electricity generation, vehicle fleet composition, etc.).

With reference to the exogenous assumptions related to technology, energy and national taxation trends, the quantification of projections were defined based on recent studies, such as e.g. European Commissions (2013), Krail et. al. (2014), Fiorello et. al. (2012).

2.6. Model calibration and validation

An internal extensive testing of the calculation framework was performed to check the consistency of the data set and to revise any assumptions leading to incorrect results. The extensive testing phase allowed also identifying mistakes in the specification of the equations, problems with inconsistent units of measures, calculation failures in case of "extreme" values and other mistakes. Namely, each policy has been tested with the tool reproducing as far as possible the context of application and the input parameters of the case studies available from literature, in order to check the correct responses and structure of the calculation framework. Furthermore, also the estimation of indicators for the reference scenario has been tested in various configurations of urban areas, in order to validate the results of the reference case.

A beta version of the tool has been handed over for full testing to selected case study cities beginning of September 2015. From September to October 2015 tester cities - supported by the project team - used the tool to develop their scenarios and roadmaps customised on their urban environment and provided feedbacks contributing in the tool development.

3. Conclusions

This paper has introduced the main features of the Urban Transport Roadmaps 2030 policy support tool. The tool has been developed within the four-year project "Study on European Urban Transport Roadmaps 2030", promoted and financed by DG MOVE of the European Commission. The tool has been designed to help city authorities in developing and analysing policy scenarios and roadmaps. It allows policy screening of a wide range of transport policy

measures and of their combinations providing users with quantified estimates of their impacts and costs. The tool operates in a web-based software environment to enable ease and use and to avoid the need for cities to have access to specific software packages. It is conceived to work with a limited amount of data provided by users and with different levels of customisation of its applications. The tool cannot replace detailed transport and land use models but it is expected to be useful for initial policy analysis especially for smaller and medium sized cities that might not have the resources to develop more complex modelling applications.

The on line version of the tool, available in 10 European languages, will be available beginning 2016. In the course of the years 2016 and 2017 the tool will be promoted throughout the 28 European countries via launch events encompassing both online webinars and in-person events.

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